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# MEMORANDUM

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| DATE: | August 15, 2003 |
| TO: | Installed Capacity Working Group |
| FROM: | Mike Cadwalader |
| RE: | Shaping In-city Installed Capacity Price Caps |

At the July 28 meeting of the Installed Capacity Working Group, I briefly described the methodology I had used to derive the formula that should be used to determine the summer and winter price caps applicable to in-city providers of installed capacity. This memorandum describes that derivation in more detail.

## THE FIRST CONSTRAINT

The tariff requires that the price caps must be set at levels that would permit each of the divested generation owners (DGOs) the opportunity to realize its annual revenue cap for the mitigated capacity that it owns. This yields the first constraint on the levels of summer and winter price caps. If we define $R_n$ as the ratio of (1) the sum of the winter generating capacities of all mitigated in-city generation owned by DGO *n* to (2) the sum of the summer generating capacities of all mitigated in-city generation owned by DGO *n*; then for every MW of summer generating capacity that DGO *n* owns, it owns $R_n$ MW of winter generating capacity. Therefore, this constraint states that if the revenue it earns is equal to the price cap applicable to each month, it can earn up to six times the monthly summer price cap for that MW of capacity during the summer, and six times $R_n$ times the monthly winter cap for the corresponding amount of capacity sold during the winter. We can write this constraint as:

$$6 \cdot MSPC_n + 6 \cdot R_n \cdot MWPC_n = AMPC, \qquad (1)$$

where:

$MSPC_n$ is the monthly summer price cap for DGO *n*;

$R_n$ is as defined above;

$MWPC_n$ is the monthly winter price cap for DGO *n*; and

*AMPC* is the annual mitigated price cap.

These variable definitions match those included in the document dated May 6 that John Charlton distributed that describes the ISO's proposal, as do all of the variable definitions that I use here. This constraint is consistent with the equation appearing at the bottom of the ISO's May 6 proposal, although it has been rewritten slightly.

### THE SECOND CONSTRAINT

There are many combinations of values for $MSPC_n$ and $MWPC_n$ that will satisfy equation (1), because we have two variables, and only one equation. In order to determine what values should be used for $MSPC_n$ and $MWPC_n$, we need to use some other criterion to select from among these many combinations of values. This criterion would provide the second equation that would permit us to solve for $MSPC_n$ and $MWPC_n$.[1]

To determine such an equation, we need to posit some sort of relationship between $MSPC_n$ and $MWPC_n$. It seems to me that the most reasonable such relationship should base the ratio of the summer price cap to the winter price cap on the expected ratio of summer ICAP prices to winter ICAP prices.

- Suppose, for example, that summer and winter DMNCs were almost identical. Then summer and winter ICAP prices should be nearly identical (since ICAP requirements are the same during the summer and the winter), so the summer and winter price caps should also be very similar, since there is little difference between the summer and winter markets.

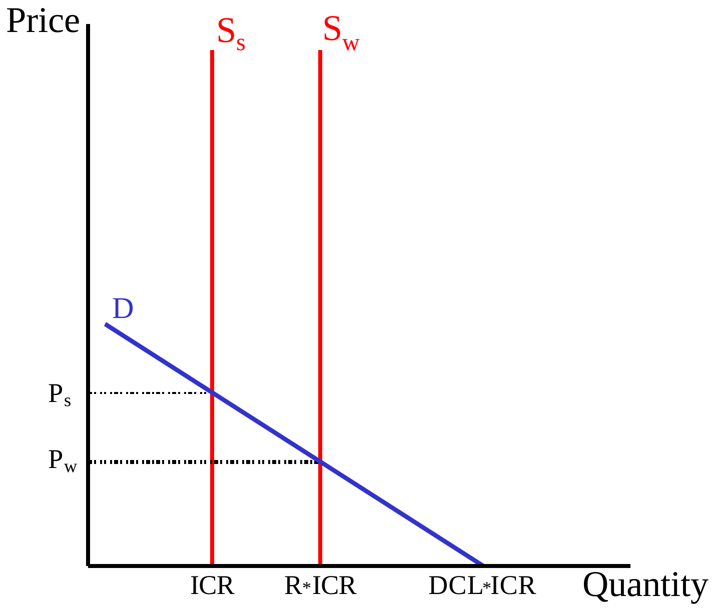
- If we were to make the reverse assumption, and assume that.winter DMNCs were far larger than summer DMNCs, driving winter ICAP prices down to near zero, then summer capacity would be far more valuable than winter capacity. In that case, the summer price cap should be much larger than the winter price cap.

In fact, if the caps are not calculated in a way to ensure that this occurs, then DGOs might stand little chance of actually achieving their annual revenue cap, even though the caps might technically permit it. If winter capacity were virtually free, but the price caps were calculated in a way that assigned a large portion of the permitted annual revenue to the winter, the DGOs probably would not be able to realize that portion of their permitted annual revenue.

For a given demand curve, we can fairly easily determine the expected ratio of summer to winter prices for a given amount of ICAP. Suppose that we have just enough ICAP to meet the in-city ICAP requirement, and define $P_s$ as the price during the summer corresponding to that amount of ICAP, given that demand curve. The amount of ICAP that group of resources will be able to provide in the winter would then be equal to $R$ x $ICR$, where $R$ is the ratio of (1) the sum of the winter generating capacities of all

[1] Requiring each monthly cap to be less than the price that corresponds to meeting 100 percent of the in-city requirement will eliminate some possible sets of caps, but it still leaves many possible sets of caps, and so we still need an additional criterion to permit us to solve for the caps.

mitigated in-city generation to (2) the sum of the summer generating capacities of all mitigated in-city generation, and *ICR* is the in-city ICAP requirement (in MW). The winter price, $P_w$, for the amount of ICAP that this group of resources will provide (using the same demand curve for summer and winter) will depend on *R*. The larger the value of R, the further down the demand curve we go in the winter, and the lower the price in the winter (and the smaller the ratio of $P_w$ to $P_s$).




Since the ICAP demand curve is a straight line that passes through the points (*ICR*, $P_s$) and (*DCL* x *ICR*, 0), where *DCL* is the ratio of (1) the amount of in-city ICAP at which the demand curve reaches a zero price to (2) the in-city ICAP requirement, as the diagram illustrates, we can write the ICAP demand curve using a parametric formulation as follows:

$$P = P_s - \frac{P_s}{DCL \cdot ICR - ICR} \cdot (Q - ICR).$$

Since the amount of capacity provided by this group of resources during the winter is *R* x *ICR*, we can insert *Q* = *R* x *ICR* into this equation to solve for $P_w$:

$$P_w = P_s - \frac{P_s}{DCL \cdot ICR - ICR} \cdot (R \cdot ICR - ICR).$$

A little algebra yields:

$$P_w = P_s \cdot \frac{DCL - R}{DCL - 1}.$$

Consequently, the ratio of the winter price to the summer price is:

$$\frac{P_w}{P_s} = \frac{DCL - R}{DCL - 1},$$

and therefore the ratio of each DGO's winter cap to its summer cap should be:

$$\frac{MWPC_n}{MSPC_n} = \frac{DCL - R}{DCL - 1}. \qquad (2)$$

### SOLVING FOR THE CAPS

If we solve equations (1) and (2) together, we get:

$$MSPC_n = \frac{AMPC}{6 \cdot \left(1 + R_n \cdot \frac{DCL - R}{DCL - 1}\right)}$$

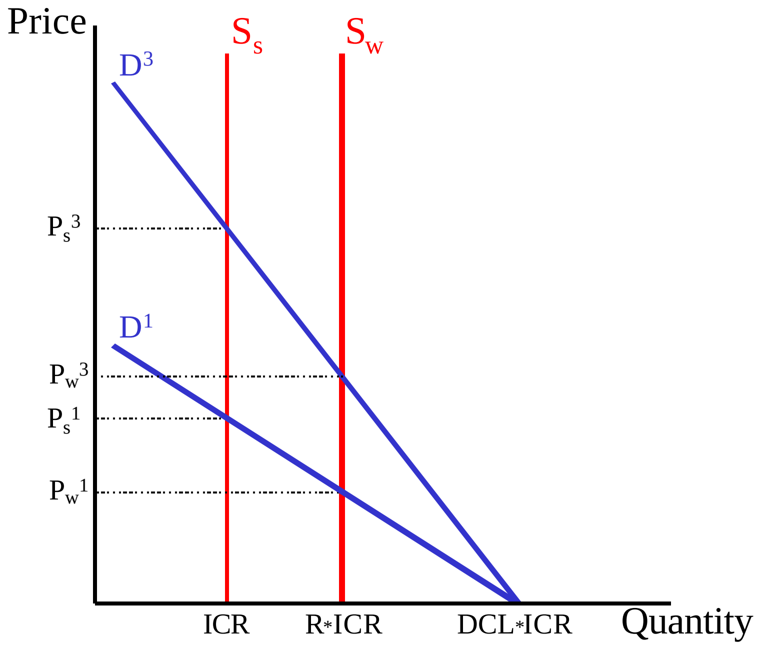
and

$$MWPC_n = MSPC_n \cdot \frac{DCL - R}{DCL - 1},$$

which, as it happens, exactly match the equations that Steve Wemple used in the examples of an alternative to the Charlton proposal that he illustrated earlier.

### APPLICATION IN FUTURE YEARS

In years 2 and 3, the ICAP demand curve will shift upward. However, the point at which the demand curve intersects the x-axis will remain the same. As a result, the demand curve will pivot around the point (*DCL* x *ICR*, 0), as illustrated in the diagram below.




Assume a constant set of ICAP providers and a constant ratio of winter supply to summer supply so that we can consider the effects of shifts in the demand curve over time in isolation. As the diagram illustrates, the shift in the ICAP demand curve would increase summer ICAP prices. However, it would also increase winter prices, so that the ratio of winter prices to summer prices does not change. For example, if the slope of $D_3$, the year 3 demand curve, is twice the slope of the year 1 demand curve, then $P_s^3$, the summer price in year 3, would be twice as high as $P_s^1$, the summer price in year 1. But $P_w^3$, the winter price in year 3, would be twice as high as $P_w^1$, the winter price in year 1, so the ratio of the winter price to the summer price would be the same in both years, even though the demand curve has shifted upward.

In cases such as this, in which the relative prices of ICAP in the winter and in the summer remain the same, there is no reason for the summer and winter caps to change. This is one of the more troublesome elements of the ISO proposal, as the summer and winter caps do change under these circumstances. Under the proposal that Steve Wemple illustrated and that I derived above, the caps do not change, because the determination of the ratio of the winter caps to the summer caps is based on the expected ratio of winter prices to summer prices, and nothing has happened to change that latter ratio.

### VARYING ASSUMPTIONS

Above, I determined the ratio of winter prices to summer prices based on the following assumptions:

- The amount of capacity will be just sufficient to meet the summer in-city ICAP requirement.
- The same resources will provide in-city ICAP in the summer and in the winter.

Changing either of these assumptions would change the results.

If we assume that the amount of capacity that will be supplied during the summer will not be equal to the in-city requirement, we would get different summer and winter prices, which we can call $P_S'$ and $P_W'$, respectively. So if the amount of ICAP available during the summer was $k$ x $ICR$, then the amount available during the winter would be $kR$ x $ICR$. We can then use the equation given above for the ICAP demand curve to solve for the summer and winter prices, which will yield

$$P_s' = P_s \cdot \frac{DCL - k}{DCL - 1} \text{ and } P_w' = P_s \cdot \frac{DCL - kR}{DCL - 1}.$$

In that case,

$$\frac{P_w'}{P_s'} = \frac{DCL - kR}{DCL - k} \neq \frac{DCL - R}{DCL - 1} = \frac{P_w}{P_s}.$$

However, since the ICAP demand curve has been designed with the intent of ensuring development of sufficient capacity to meet the in-city requirement, it seems most reasonable to me to calculate this ratio based on the prices that would result if just enough capacity to meet the in-city requirement during the summer were supplied. The actual ratio of winter prices to summer prices will decrease when there is more in-city capacity than is needed to meet summer requirements, and it will increase when there is less in-city capacity available than is needed to meet summer requirements. On average, these errors should balance out over time.

We could also take into account the fact that supply may respond to price, and as a result, not all resources that offer capacity during the summer will necessarily offer capacity during the winter as well. This would tend to increase winter prices to the level marked $P_W''$ in the diagram below. Using $P_W''$ instead of $P_W$ to determine the ratio of winter caps to summer caps would increase winter caps, and decrease summer caps.

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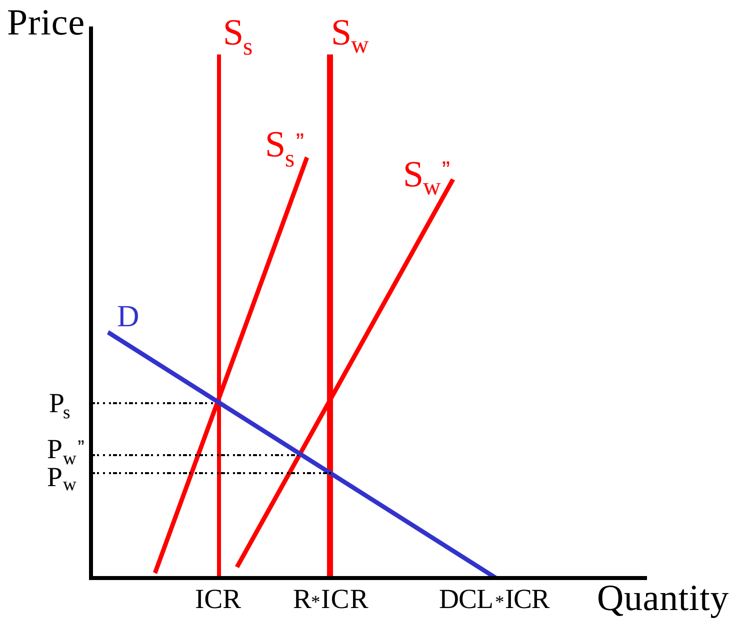


However, while there may be some decrease in supply during the winter due to the decreased prices during the winter, the response is not likely to be large. Demand-response resources might not participate in the market, but their share of the market is relatively tiny. In-city generators are likely to find the opportunity to meet in-city ICAP requirements more lucrative than opportunities elsewhere during both the summer and the winter, so any errors introduced by the assumption that the supply curve is vertical and does not respond to price are likely to be quite small.